US008464250B1

(12) **United States Patent**
Ansel

(10) **Patent No.: US 8,464,250 B1**
(45) **Date of Patent: Jun. 11, 2013**

(54) **SYSTEM AND METHOD FOR ON-DEMAND CLONING OF VIRTUAL MACHINES**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1722 days.

(21) Appl. No.: **10/948,381**

(22) Filed: **Sep. 23, 2004**

(51) **Int. Cl.**
G06F 9/455 (2006.01)
G06F 9/46 (2006.01)
G06F 15/177 (2006.01)

(52) **U.S. Cl.**
USPC **718/1**; 718/100; 709/220

(58) **Field of Classification Search**
USPC 718/100, 102, 104; 709/225, 229
See application file for complete search history.

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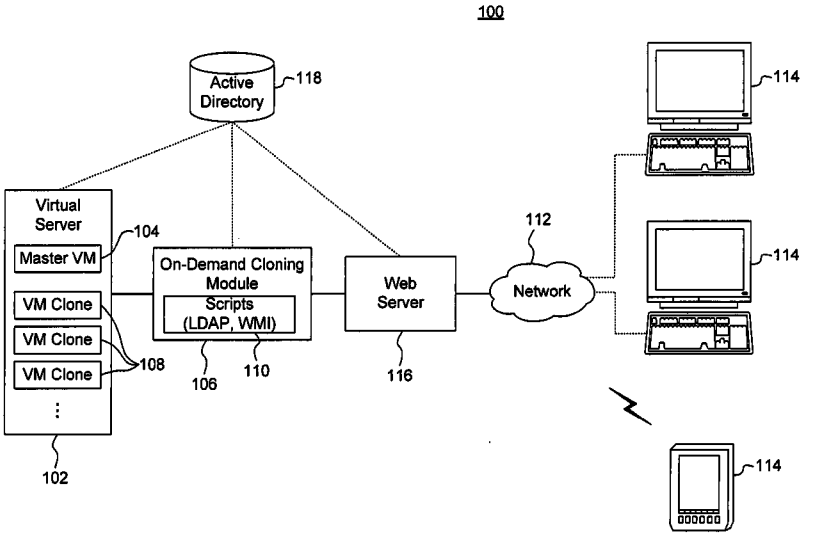
(57) **ABSTRACT**

A system for on-demand cloning of virtual machines (VMs) includes a virtual server to host a number of VMs, the virtual server including at least one master VM. The system also includes a Web server to authenticate a user in response to a request for online access to a new VM on the virtual server. In addition, the system includes a cloning module, in communication with the Web server and the virtual server, to automatically clone the master VM to create a unique VM clone for the user on the virtual server responsive to the request.

52 Claims, 13 Drawing Sheets



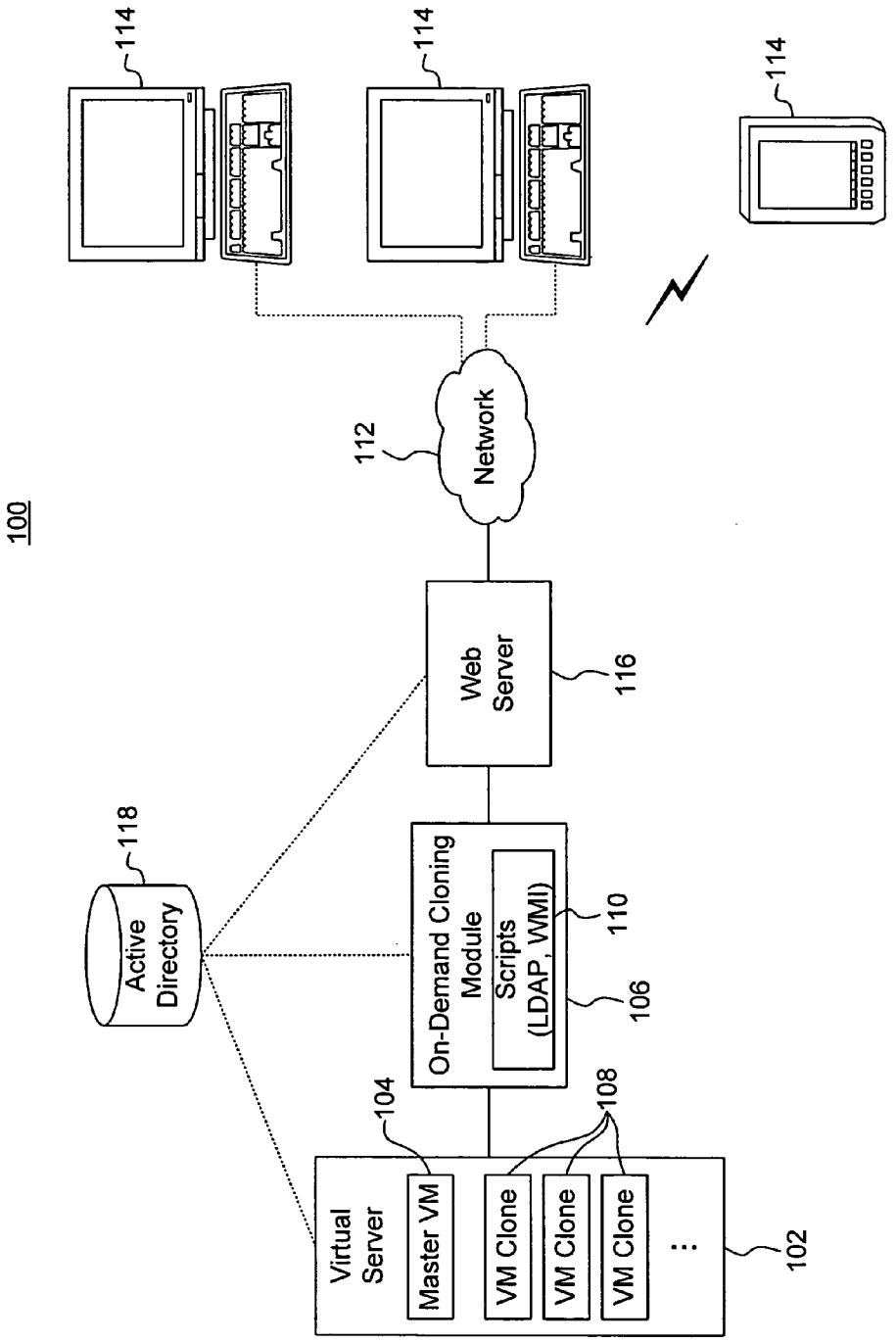

100
114
114
114
112
Network
Web Server
116
118
Active Directory
On-Demand Cloning Module
Scripts (LDAP, WMI)
110
106
104
108
Virtual Server
Master VM
VM Clone
VM Clone
VM Clone
102

FIG. 1

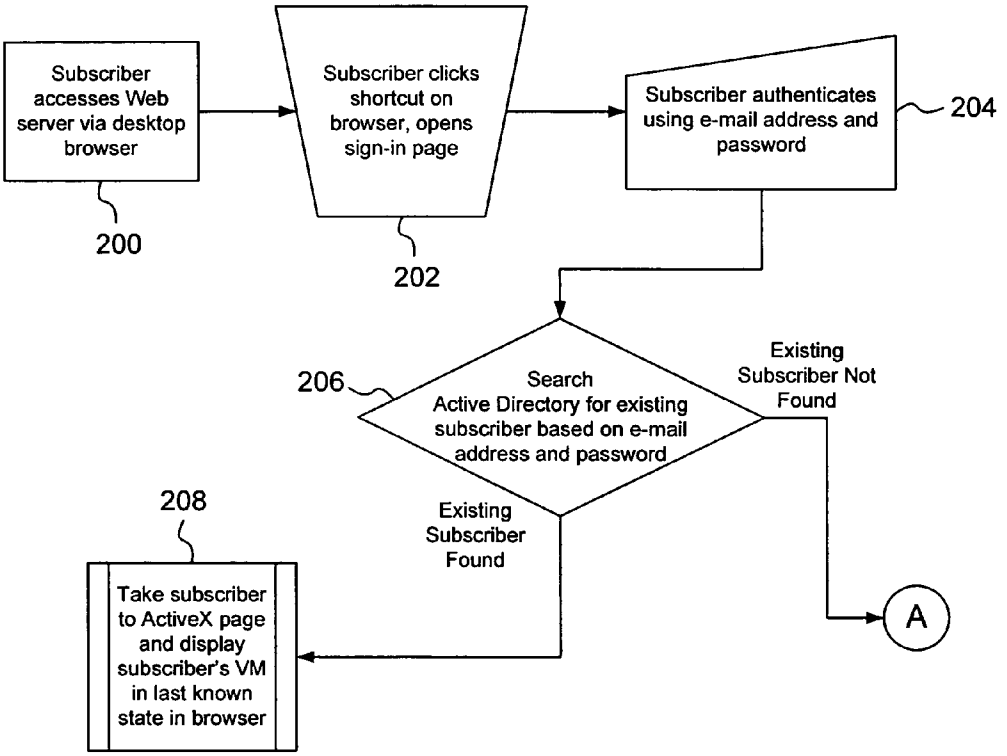

Subscriber accesses Web server via desktop browser
200
Subscriber clicks shortcut on browser, opens sign-in page
202
Subscriber authenticates using e-mail address and password
204
206
Search Active Directory for existing subscriber based on e-mail address and password
Existing Subscriber Not Found
Existing Subscriber Found
208
Take subscriber to ActiveX page and display subscriber's VM in last known state in browser
A

FIG. 2A

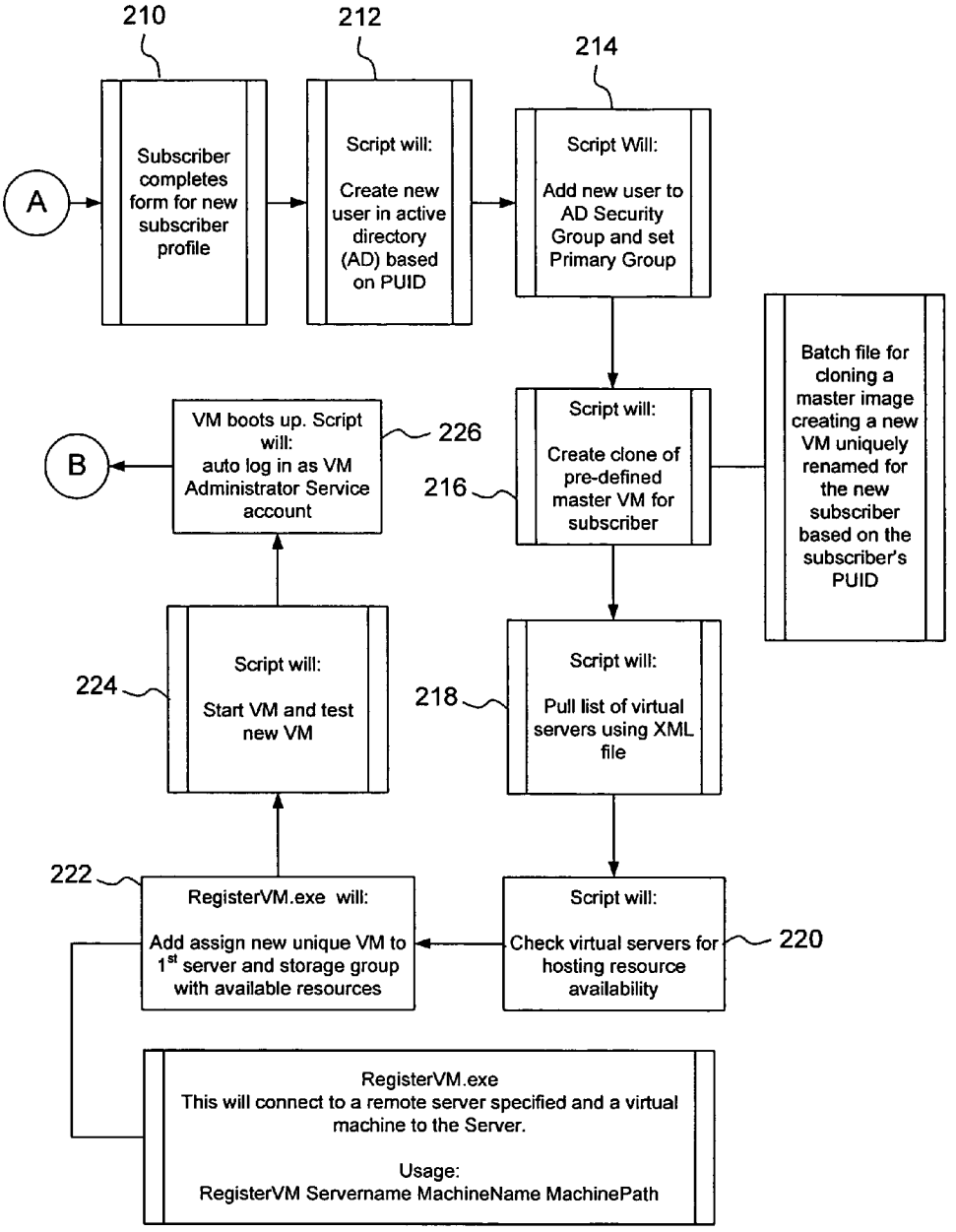

210
212
214
A
Subscriber completes form for new subscriber profile
Script will:
Create new user in active directory (AD) based on PUID
Script Will:
Add new user to AD Security Group and set Primary Group
Batch file for cloning a master image creating a new VM uniquely renamed for the new subscriber based on the subscriber's PUID
B
VM boots up. Script will:
auto log in as VM Administrator Service account
226
Script will:
Create clone of pre-defined master VM for subscriber
216
224
Script will:
Start VM and test new VM
218
Script will:
Pull list of virtual servers using XML file
222
RegisterVM.exe will:
Add assign new unique VM to 1st server and storage group with available resources
Script will:
Check virtual servers for hosting resource availability
220
RegisterVM.exe
This will connect to a remote server specified and a virtual machine to the Server.
Usage:
RegisterVM Servername MachineName MachinePath

FIG. 2B

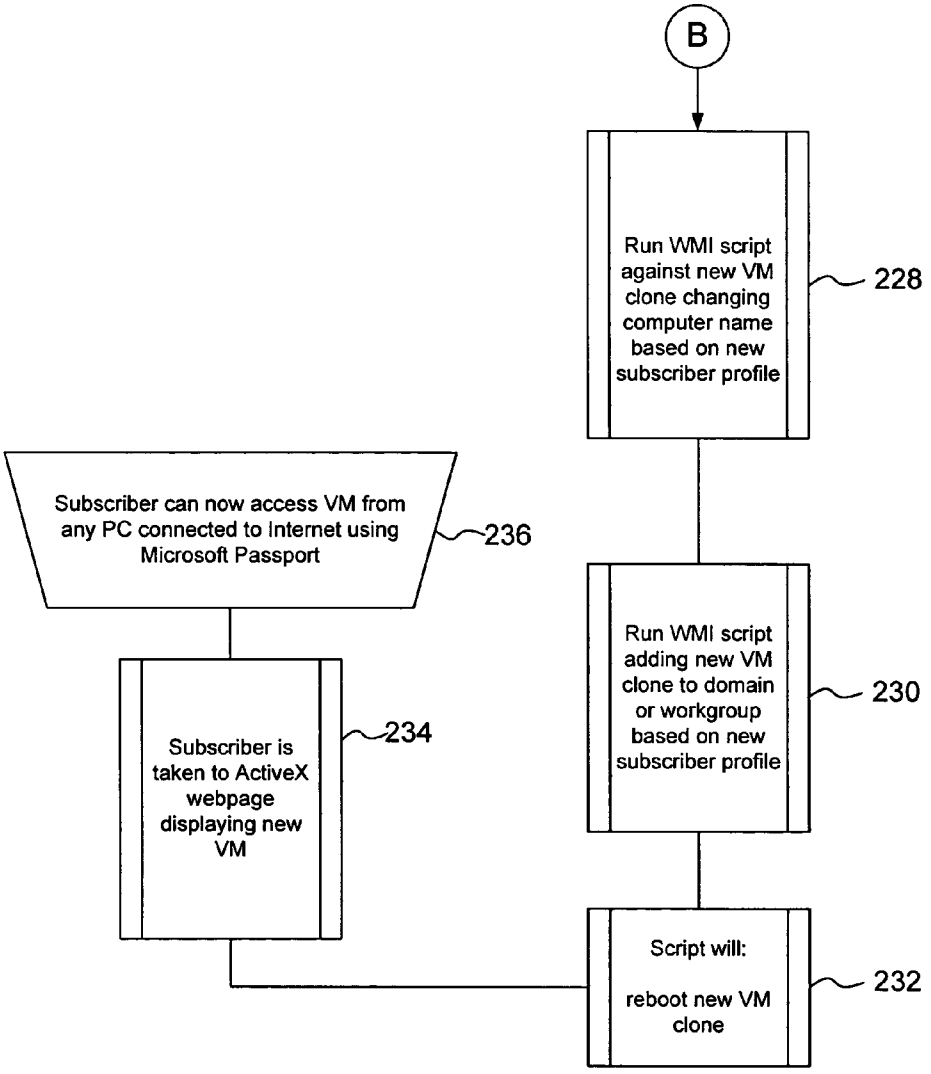

B
Run WMI script against new VM clone changing computer name based on new subscriber profile
228
Run WMI script adding new VM clone to domain or workgroup based on new subscriber profile
230
Script will:
reboot new VM clone
232
Subscriber is taken to ActiveX webpage displaying new VM
234
Subscriber can now access VM from any PC connected to Internet using Microsoft Passport
236

FIG. 2C

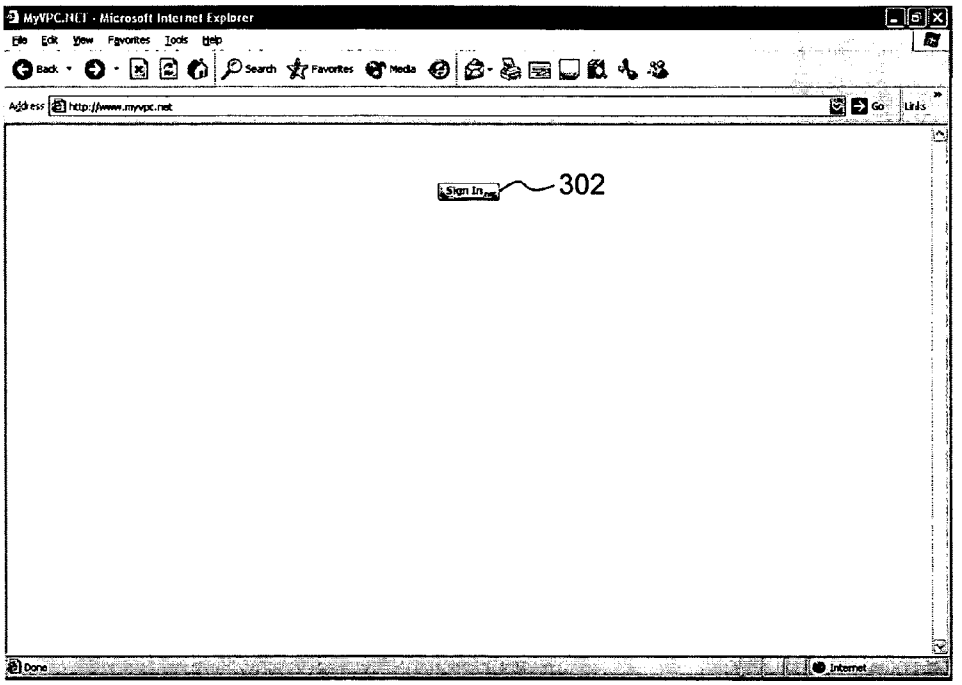

MyVPC.NET - Microsoft Internet Explorer
Sign In
302

FIG. 3

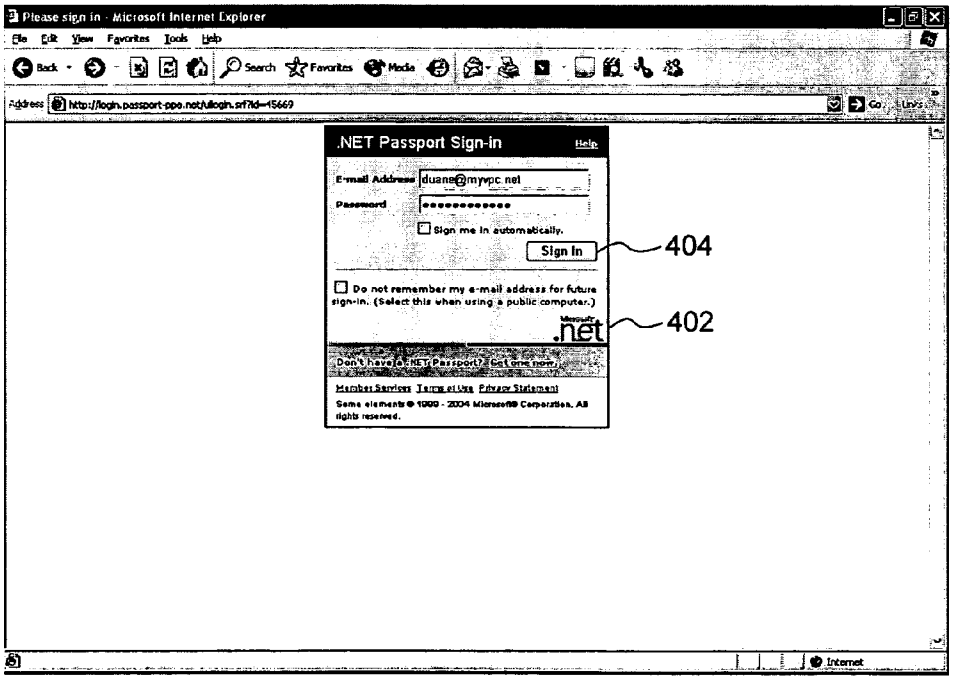

Please sign in - Microsoft Internet Explorer
.NET Passport Sign-in
Sign In
404
402

FIG. 4

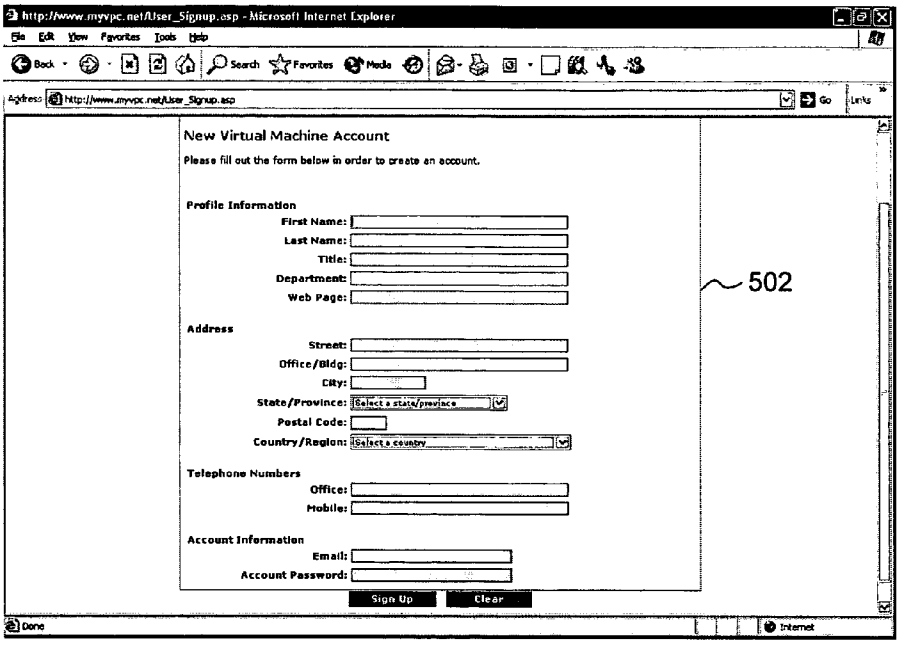

http://www.myvpc.net/User_Signup.asp - Microsoft Internet Explorer
New Virtual Machine Account
Please fill out the form below in order to create an account.
Profile Information
First Name:
Last Name:
Title:
Department:
Web Page:
Address
Street:
Office/Bldg:
City:
State/Province:
Postal Code:
Country/Region:
Telephone Numbers
Office:
Mobile:
Account Information
Email:
Account Password:
Sign Up
Clear
502

FIG. 5

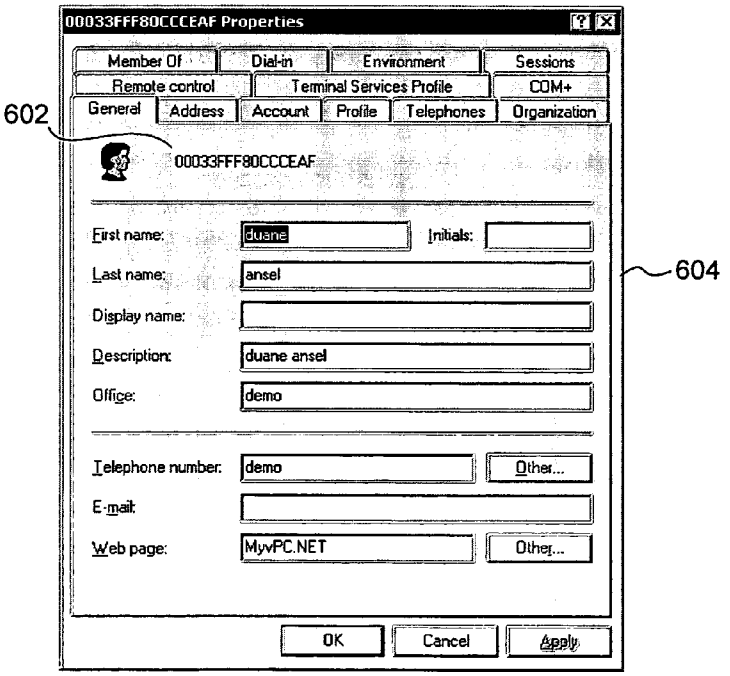

00033FFF80CCCEAF Properties
Member Of
Dial-in
Environment
Sessions
Remote control
Terminal Services Profile
COM+
General
Address
Account
Profile
Telephones
Organization
602
00033FFF80CCCEAF
First name:
duane
Initials:
Last name:
ansel
Display name:
Description:
duane ansel
Office:
demo
Telephone number:
demo
Other...
E-mail:
Web page:
MyvPC.NET
Other...
OK
Cancel
Apply
604

FIG. 6

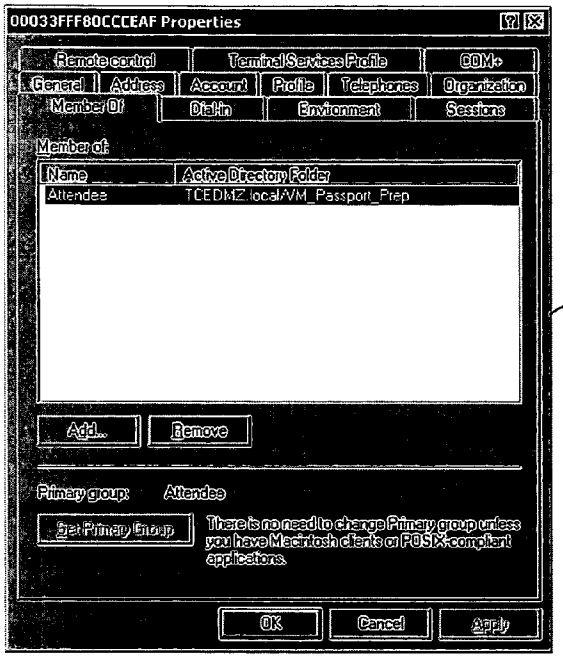

00033FFF80CCCEAF Properties
Remote control
Terminal Services Profile
COM+
General
Address
Account
Profile
Telephones
Organization
Member Of
Dial-in
Environment
Sessions
Member of:
Name
Active Directory Folder
Attendee
TCEDMZ.local/VM_Passport_Prep
Add...
Remove
Primary group:
Attendee
Set Primary Group
There is no need to change Primary group unless you have Macintosh clients or POSIX-compliant applications.
OK
Cancel
Apply
604

FIG. 7

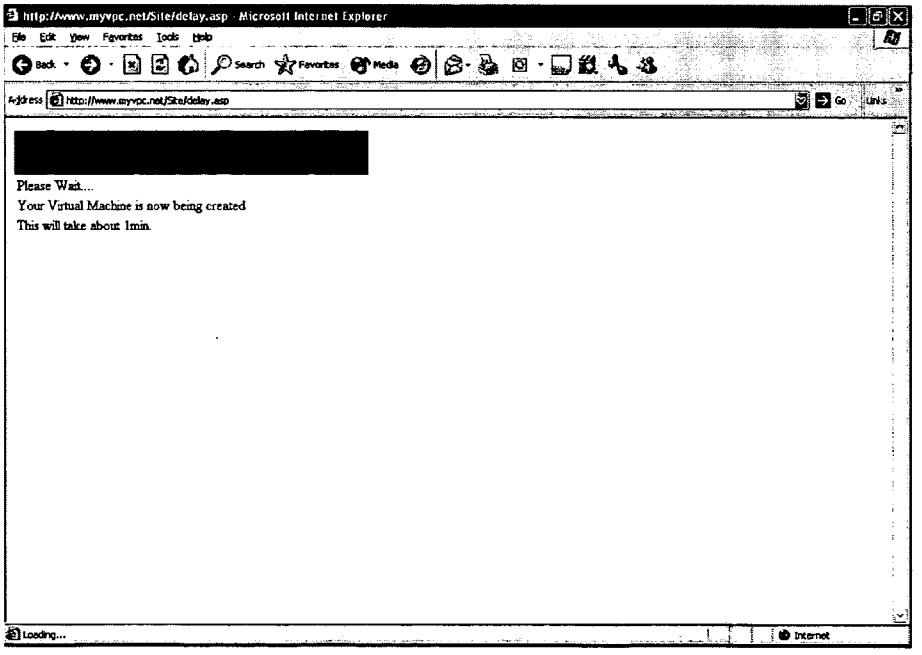

http://www.myvpc.net/Site/delay.asp - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back
Search
Favorites
Media
Address
http://www.myvpc.net/Site/delay.asp
Go
Links
[redacted]
Please Wait....
Your Virtual Machine is now being created
This will take about 1min.
Loading...
Internet

FIG. 8

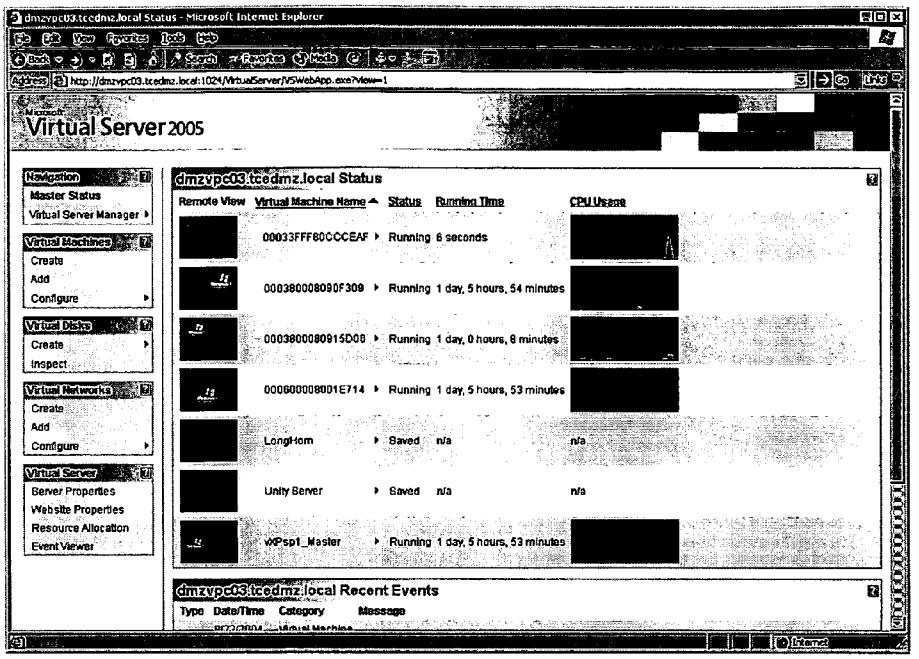

Virtual Server 2005
Navigation
Master Status
Virtual Server Manager
Virtual Machines
Create
Add
Configure
Virtual Disks
Create
Inspect
Virtual Networks
Create
Add
Configure
Virtual Server
Server Properties
Website Properties
Resource Allocation
Event Viewer
dmzvpc03.tcedmz.local Status
Remote View
Virtual Machine Name
Status
Running Time
CPU Usage
00033FFF80CCCEAF
Running 6 seconds
0003800080908309
Running 1 day, 5 hours, 54 minutes
0003800080915D06
Running 1 day, 0 hours, 8 minutes
0006000080016714
Running 1 day, 5 hours, 53 minutes
LongHorn
Saved n/a n/a
Unity Server
Saved n/a n/a
WPsp1_Master
Running 1 day, 5 hours, 53 minutes
dmzvpc03.tcedmz.local Recent Events
Type
Date/Time
Category
Message

FIG. 9

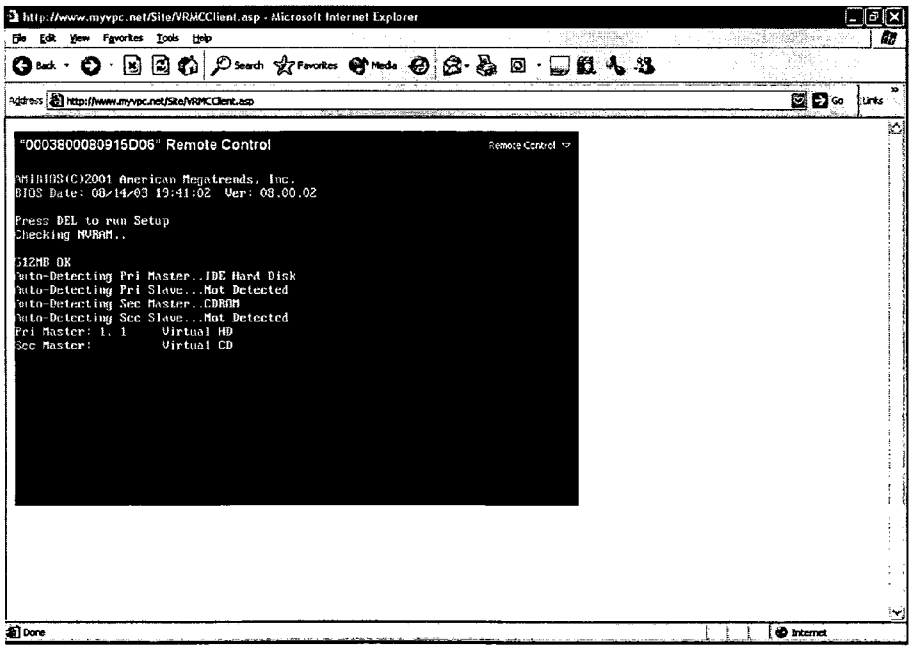

"0003800080915D06" Remote Control
Remote Control
AMIBIOS(C)2001 American Megatrends, Inc.
BIOS Date: 08/14/03 19:41:02 Ver: 08.00.02
Press DEL to run Setup
Checking NVRAM..
512MB OK
Auto-Detecting Pri Master...IDE Hard Disk
Auto-Detecting Pri Slave...Not Detected
Auto-Detecting Sec Master...CDROM
Auto-Detecting Sec Slave...Not Detected
Pri Master: 1. 1 Virtual HD
Sec Master: Virtual CD

FIG. 10

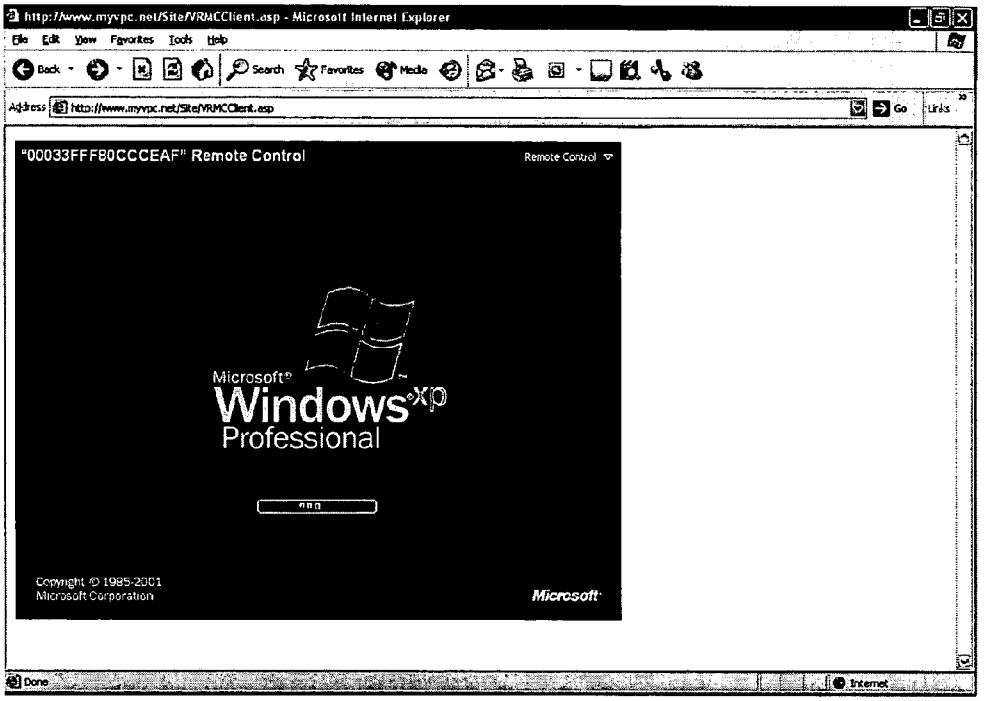

http://www.myvpc.net/Site/VRMCClient.asp - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://www.myvpc.net/Site/VRMCClient.asp
Go Links
"00033FFF80CCCEAF" Remote Control
Remote Control
Microsoft
Windows xp
Professional
Copyright © 1985-2001
Microsoft Corporation
Microsoft
Done
Internet

FIG. 11

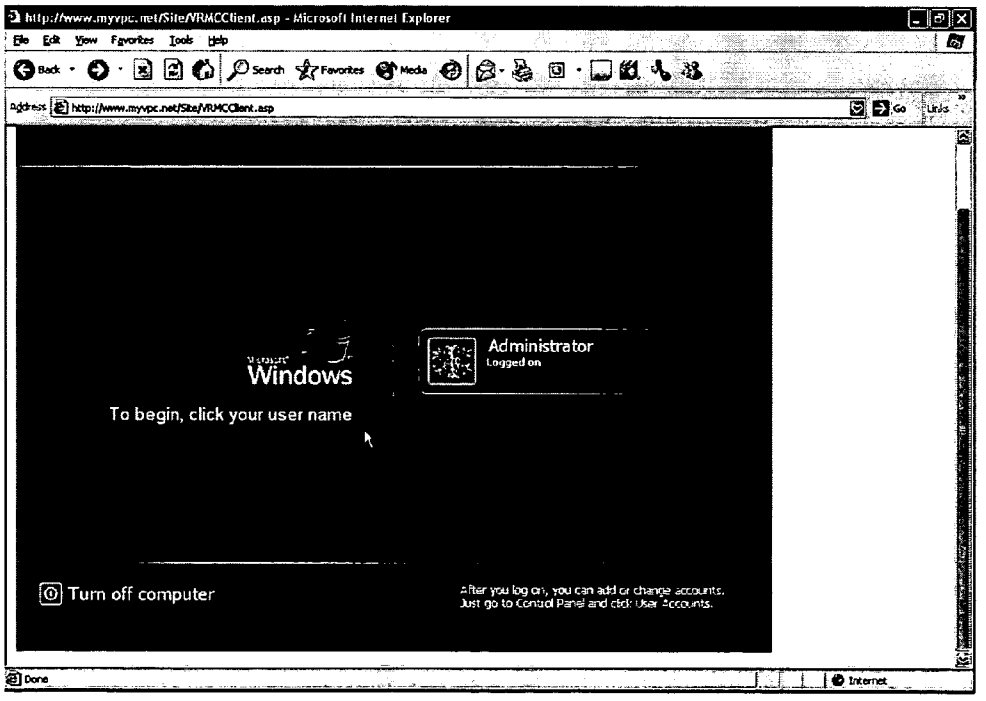

http://www.myvpc.net/Site/VRMCClient.asp - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://www.myvpc.net/Site/VRMCClient.asp
Go Links
Windows
To begin, click your user name
Administrator
Logged on
Turn off computer
After you log on, you can add or change accounts.
Just go to Control Panel and click User Accounts.
Done
Internet

FIG. 12

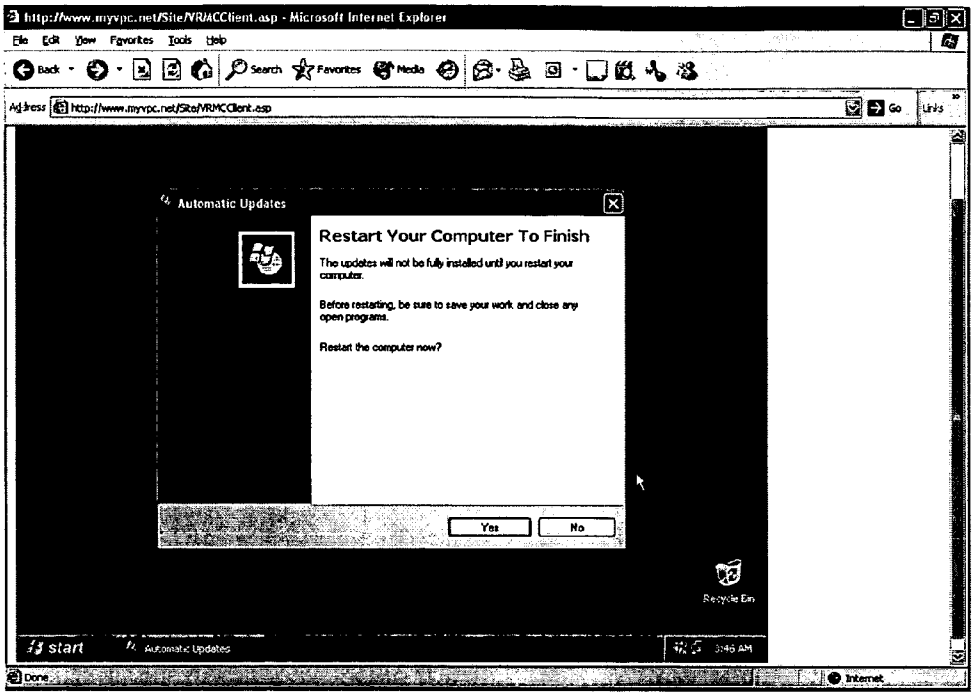

http://www.myvpc.net/Site/VRIACClient.asp - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.myvpc.net/Site/VRIACClient.asp
Automatic Updates
Restart Your Computer To Finish
The updates will not be fully installed until you restart your computer.
Before restarting, be sure to save your work and close any open programs.
Restart the computer now?
Yes
No
start
Automatic Updates
Done
Internet

FIG. 13

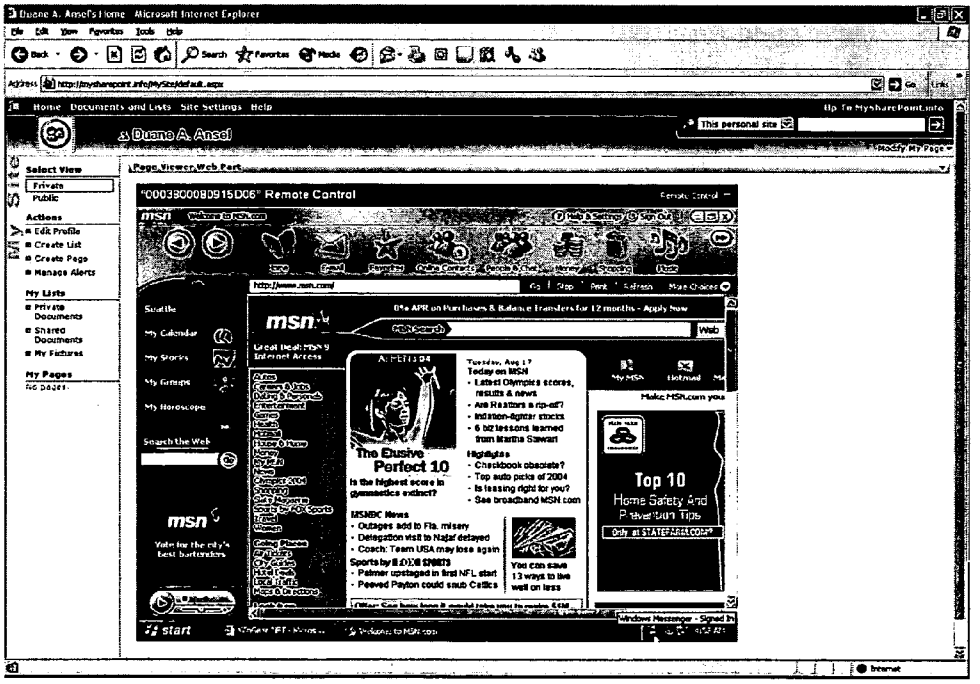

Duane A. Ansel's Home - Microsoft Internet Explorer
Duane A. Ansel
"00038000B0915D06" Remote Control
msn
The Elusive Perfect 10
Top 10
Home Safety And Prevention Tips
start

FIG. 14

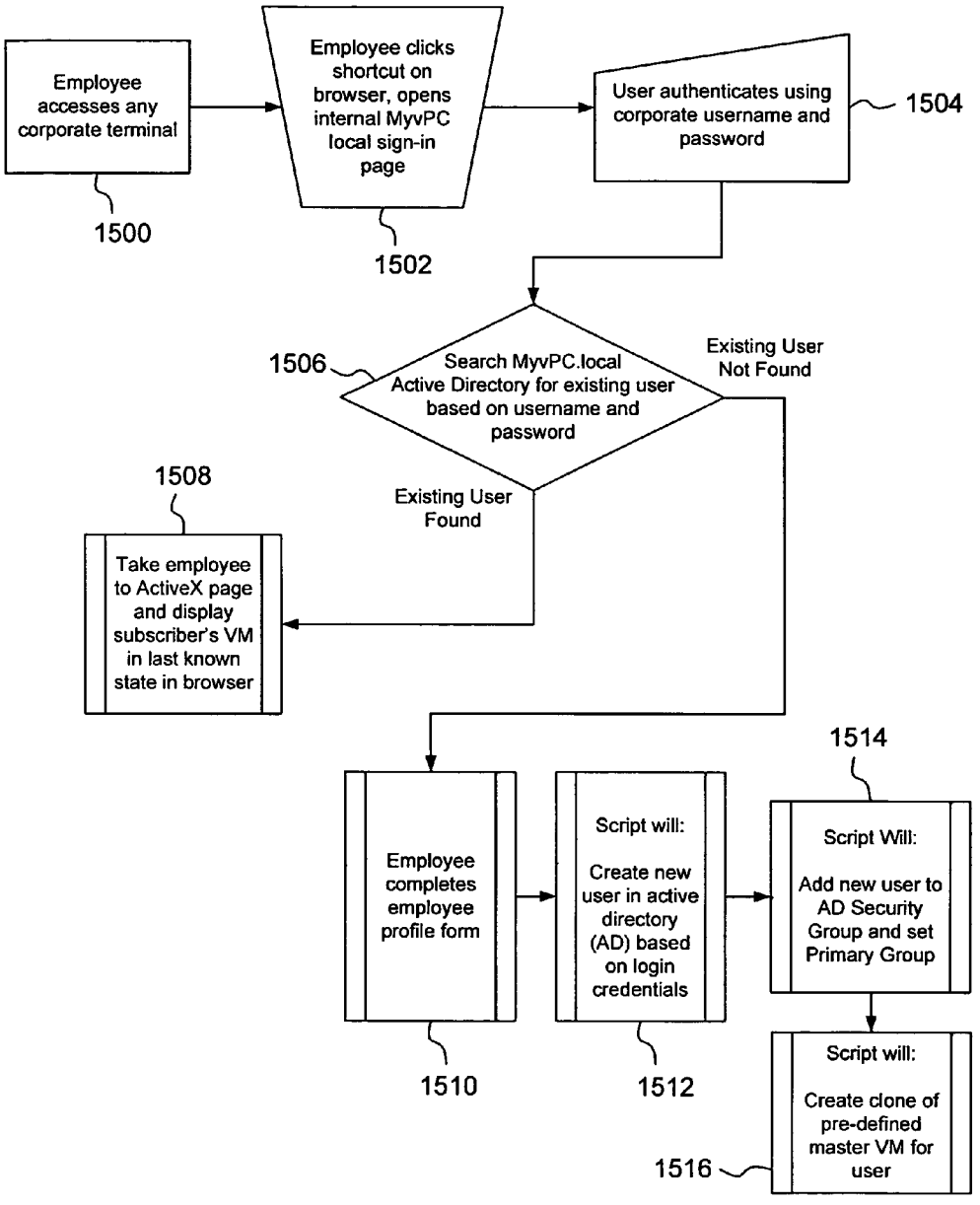

Employee accesses any corporate terminal
1500
Employee clicks shortcut on browser, opens internal MyvPC local sign-in page
1502
User authenticates using corporate username and password
1504
1506
Search MyvPC.local Active Directory for existing user based on username and password
Existing User Not Found
Existing User Found
1508
Take employee to ActiveX page and display subscriber's VM in last known state in browser
Employee completes employee profile form
1510
Script will:
Create new user in active directory (AD) based on login credentials
1512
1514
Script Will:
Add new user to AD Security Group and set Primary Group
Script will:
Create clone of pre-defined master VM for user
1516

FIG. 15

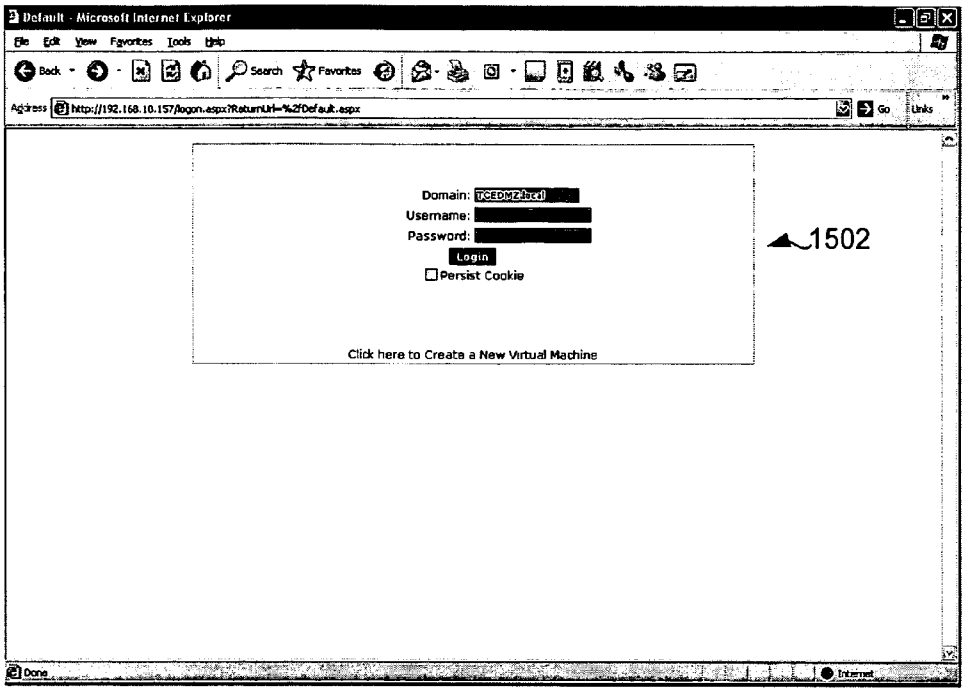

Default - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.10.157/logon.aspx?ReturnUrl=%2fDefault.aspx
Go Links
Domain:
Username:
Password:
Login
Persist Cookie
Click here to Create a New Virtual Machine
1502
Done
Internet

FIG. 16

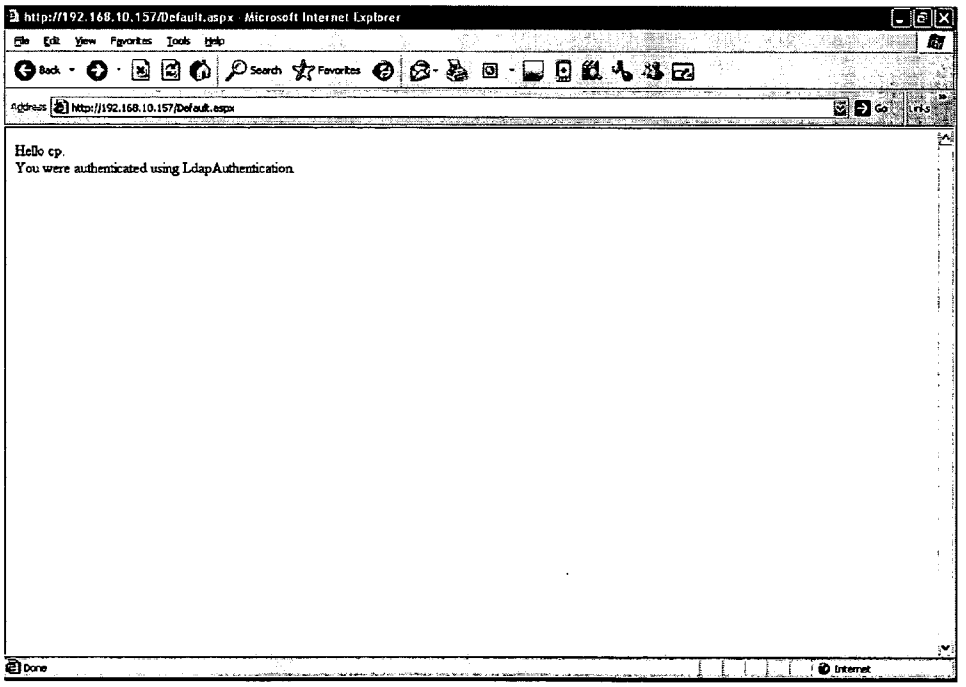

http://192.168.10.157/Default.aspx - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.10.157/Default.aspx
Go
Hello cp.
You were authenticated using LdapAuthentication.
Done
Internet

FIG. 17

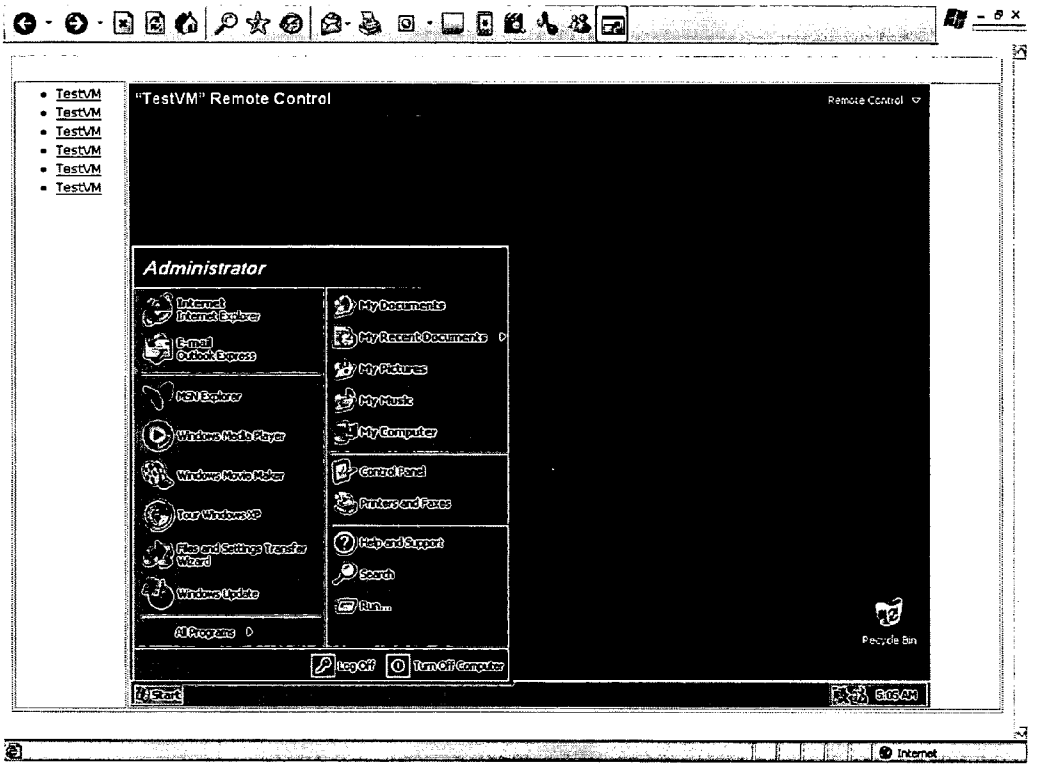

TestVM
TestVM
TestVM
TestVM
TestVM
TestVM
"TestVM" Remote Control
Remote Control
Administrator
Internet
Internet Explorer
E-mail
Outlook Express
MSN Explorer
Windows Media Player
Windows Movie Maker
Tour Windows XP
Files and Settings Transfer Wizard
Windows Update
All Programs
My Documents
My Recent Documents
My Pictures
My Music
My Computer
Control Panel
Printers and Faxes
Help and Support
Search
Run...
Log Off
Turn Off Computer
Recycle Bin
start
5:05 AM
Internet

FIG. 18

SYSTEM AND METHOD FOR ON-DEMAND CLONING OF VIRTUAL MACHINES

TECHNICAL FIELD

The present invention relates to digital computing and in particular relates to improved delivery of computing resources to remote users so as to minimize the burdens and inconvenience imposed on such users.

BACKGROUND OF THE INVENTION

Personal computers "PCs" are now ubiquitous, at least in developed countries. PCs come in various form factors, including desktop models, towers, laptops, handheld devices, tablet PCs, etc. As such, the term PC or personal computer is used herein in a very broad sense, and is intended to include a wide variety of computing devices, including but not limited to the kinds just mentioned. By contrast, the term PC, as used herein, would probably not include so-called mainframe computers or other systems or clusters intended to service large numbers, e.g., thousands, of simultaneous users or tasks.

PCs, of which there are now millions in use, can be found in homes and businesses large and small. Since the advent of the PC, somewhere around 1980, they have become dramatically smaller, faster, and cheaper. For most applications, software now provides graphical user interfaces (GUIs) that enable even unsophisticated users to accomplish substantial computing tasks. That being said, using, maintaining and upgrading a modern PC is challenging for most users. In the corporate environment, many companies are large enough to afford an "IT" (information technology) department that can assist users with such tasks. In many smaller businesses and in homes (e.g., SOHO—small office/home office) situations, professional assistance is not readily available. In some cases, the user may employ on-line help or tutorials, but these resources are clumsy and few have the patience required to navigate them. In other cases, the user may pay hourly or per call charges for technical assistance.

To illustrate the burdens and challenges imposed on computer users, consider the following examples:

- Replacing a failed disk drive
- Restoring lost data resulting, e.g., from a failed memory device
- Installing frequent updates to the operating system
- Installing frequent software updates or patches to fix security issues
- Adding more user memory (typically DRAM) or other hardware
- Installing or upgrading driver software, such as printer drivers
- Configuring the computer to use various network resources
- Installing new application programs

There are other examples; these are merely illustrative. Some of these tasks are merely tiresome and annoying, while others are require technical competence beyond that of most users. Until now, no current system has been developed to alleviate such burdens on computer users.

Because most of the above-described problems stem from each user having to configure and maintain a separate PC, one approach has been to move as much of the processing as possible to central servers and allow users to access applications hosted by these central servers via the Internet. The burdens placed on the individual PCs are much less, since they only need to have basic Web browser functionality.

For example, Application Service Providers (ASPs) provide applications to individuals or organizations across the Internet or other network connections. Hosted applications can vary, but examples include financial applications (like general ledger or purchasing software) and office applications, e.g., word processors, spreadsheet programs, etc.

Unfortunately, the applications hosted by ASPs are often slow and not very responsive due to system load, network bandwidth, and latency issues. As a result, ASPs cannot generally guarantee a particular quality of service (QoS) for a given application.

Thin-client systems, like Citrix™, as well as emulation programs, such as Attachmate™, sometimes provide better performance. Attachmate™, for example, Web-enables legacy host applications. Such applications run on thin terminals, often in character mode (black screen dumb terminal). However, not every application can be made to work with emulation programs like Attachmate™. Furthermore, setting up these applications is complicated, typically requiring an IT professional to configure and maintain the application.

Another conventional technique that attempts to address the problems described above is virtual machine (VM) technology. VM technology allows multiple operating systems to run concurrently on a single machine. Each VM emulates the hardware and software of a stand-alone computer, including its CPU, sound, video, and network adapters, etc., in a self-contained, isolated environment.

In particular, Virtual PC™ and Virtual Server™, developed by Connectix and Microsoft, allow one or more legacy operating systems to run on the same computer system as the current Windows operating system. Today, many older x86-based operating systems are supported by Virtual PC and Virtual Server. Virtual PC for Mac allows for one or more other operating systems to run the Macintosh operating system, allowing users to run a Windows operating system and Windows applications on a Mac.

VM technology serves a variety of purposes. It enables hardware consolidation, because multiple operating systems can run on one computer. Key applications for VM technology include cross-platform integration as well as the following:

- Legacy application migration. Legacy operating systems and applications can run on new hardware along with more recent operating systems and applications.
- Server consolidation. If several servers run applications that consume only a fraction of the available resources, VM technology can be used to enable them to run side by side on a single server, even if they require different versions of the operating system or middleware.
- Isolation for development, testing and technical support. Each VM acts as a separate environment, which reduces risk and enables developers to quickly recreate different operating system configurations or compare versions of applications designed for different operating systems. In addition, a developer can test an early version of an application in a VM without fear of destabilizing the system for other users.
- Software demonstrations. VM technology allows users to recreate a clean operating system environment or system configuration quickly.
- Courseware delivery and training. Organizations can configure and deploy a variety of training scenarios quickly.
- Software distribution. IT groups can deliver prevalidated configurations for complex software solutions for fast deployment.

Unfortunately, VM technology also has limitations. For example, an IT professional is generally required to create

and set up each VM running on a Virtual Server. There is no automated method by which an novice user may remotely log into a Virtual Server and have a VM automatically created and initialized with all of the software and settings needed for the user to immediately begin working on a desired task.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a system for on-demand cloning of virtual machines;

FIG. **2** is a flowchart of a process for on-demand cloning of virtual machines;

FIG. **3** is a screen shot of a shortcut;

FIG. **4** is a screen shot of a sign-in page;

FIG. **5** is a screen shot of a subscriber profile form;

FIG. **6** is a screen shot of a user properties window;

FIG. **7** is a screen shot of a user properties window;

FIG. **8** is a screen shot of a Web page displayed while a VM clone is being created;

FIG. **9** is a screen shot of a user interface within a virtual server showing running VMs;

FIG. **10** is a screen shot of a boot process for an operating system;

FIG. **11** is a screen shot of a boot process for an operating system;

FIG. **12** is a screen shot of a login process for an operating system;

FIG. **13** is a screen shot of a shutdown process for an operating system;

FIG. **14** is a screen shot of a fully-configured and running VM clone;

FIG. **15** is a flowchart of a process for on-demand cloning of virtual machines in a corporate environment;

FIG. **16** is a screen shot of a sign-in page in a corporate environment;

FIG. **17** is a screen shot of a Web page displayed when a user is authenticated; and

FIG. **18** is a screen shot of a cloned virtual machine within a browser.

DETAILED DESCRIPTION

Reference is now made to the figures in which like reference numerals refer to like elements. For clarity, the first digit of a reference numeral indicates the figure number in which the corresponding element is first used.

In the following description, numerous specific details of programming, software modules, user selections, network transactions, database queries, database structures, etc., are provided for a thorough understanding of the embodiments of the invention. However, those skilled in the art will recognize that the invention can be practiced without one or more of the specific details, or with other methods, components, materials, etc.

In some cases, well-known structures, materials, or operations are not shown or described in detail in order to avoid obscuring aspects of the invention. Furthermore, the described features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

FIG. **1** is a block diagram of a system **100** for on-demand cloning of virtual machines (VMs). As previously noted, a VM emulates the hardware and software of a stand-alone computer, including its CPU, sound, video, and network adapters, etc., in a self-contained, isolated environment. In one embodiment, the system **100** includes one or more virtual servers **102**, such as Microsoft Virtual Server 2005™, for creating and managing one or more VMs.

As will be described in greater detail hereafter, the virtual server **102** may be pre-configured with one or more master VMs **104**, which are "templates" of PCs including all of the necessary software and settings. In one embodiment, the system **100** also includes an on-demand cloning module **106** for automatically creating a VM clone **108**, based on one of the master VMs **104**, whenever a user needs to use a PC with a particular configuration. As explained below, the cloning of VMs may be accomplished, in one embodiment, using one or more scripts **110**, such as LDAP (Lightweight Directory Access Protocol) and WMI (Windows Management Instrumentation) scripts.

Each VM clone **108** may be accessed and used over a network **112**, such as a Local Area Network (LAN) or the Internet, by a different remote computer **114**. In one embodiment, the ASPX framework may be used, although the system **100** is not limited to any particular framework or programming language. As illustrated, remote computers **114** may be embodied in a variety of form factors, including desktop and pocket computers. Moreover, the remote computers **114** may access the network using any both wired and wireless technology.

A standard Web server **116**, such as Microsoft's Internet Information Server (IIS) or the like, may provide the remote computers **114** with online access to VMs on the virtual server **102**. Such access may include, for example, replicating screen displays generated by the VMs on the remote computers **114**, and forwarding user input from the remote computers **114** to the respective VMs.

In one embodiment, an active directory **118** provides authentication and directory services to the virtual server **102**, on-demand cloning module **106**, and Web server **116**. An active directory **118** is a hierarchical collection of network resources that can contain users, computers, printers, and other Active Directories. Active Directory Services (ADS) allow administrators to handle and maintain all network resources from a single location.

FIG. **2** is a flowchart of an exemplary process for on-demand cloning of VMs. While the process is shown in the context of a subscriber establishing a new VM for use over the Internet, a similar process could provide VMs to employees within a corporation or the like, as will be described hereafter.

Referring to block **200** of FIG. **2**A, a subscriber uses a Web browser to access the Web server **116** of FIG. **1**. This may be accomplished, for example, by providing the Web browser with a URL (Uniform Resource Locator) of the Web server **116**, e.g., www.myvpc.net.

Continuing to block **202**, the subscriber clicks on a shortcut displayed in the browser in order to open a sign-in page. An example of a shortcut **302** is shown in FIG. **3**. One possible sign-in page **402** is shown in FIG. **4**. In this example, the sign-in page **402** is a .NET Passport sign-in page, although other authentication technologies may be used. In block **204**, the subscriber authenticates with the system **100** by providing one or more login credentials and password (assuming a .NET Passport has already been established for the subscriber), after which the subscriber may click on a "sign-in" button **404** or the like.

In block **206**, the system may search the active directory **118** of FIG. **1** for an existing subscriber based on the subscriber's PUID (.NET Passport Unique ID). In one embodiment, the PUID is returned by the sign-in page **402** when the subscriber is successfully authenticated. NET Passport is a Microsoft-operated service that provides Internet authentication for Web sites, no matter what kind of devices they use for access. It provides reliable Internet authentication and allows users to sign in once to access a variety of .NET Passport-

enabled Web sites. To log in to a Passport-enabled site, users present credentials to Passport (via the SSI interface) and get an encrypted ticket cookie containing PUID that is decrypted by the site and used to authenticate them. A PUID is a 16-character string in the HexPUID property of the PassportIdentity class.

If an existing subscriber (PUID) is found in the active directory **118**, control passes to block **208**, in which the subscriber is taken to an ActiveX page that displays, in the subscriber's browser, his or her VM in its last known state. While ActiveX is used to display the VM in one embodiment, other technologies may be used within the scope of the invention.

If, however, an existing subscriber is not found, control passes to block **210** of FIG. **2**B, in which the subscriber is asked to complete a profile form. As shown in FIG. **5**, a subscriber profile form **502** may require the subscriber to provide, for example, his or her name, address, telephone number, billing information, and the like.

Once the form **502** has been completed, control passes to block **212**, in which the on-demand cloning module uses a script **110** to create a new user object in the active directory **118** based, in one embodiment, on the subscriber's PUID. An example screen shot showing the creation of a new user is provided in FIG. **6**. As illustrated, the new subscriber is identified by the 16-character PUID **602**. The relevant information may be automatically completed in the "General" tab of the user properties window **604** based on the information provided in the subscriber profile form **502**. An example script **110** for carrying out this process is as follows:

```
Imports System.DirectoryServices
Public Class User_Signup
    Inherits System.Web.UI.Page
    Protected WithEvents TABLE1 As System.Web.UI.WebControls.
Table
    Protected WithEvents btnSignUp As System.Web.UI.WebControls.
Button
    Protected WithEvents txtUsername As
System.Web.UI.WebControls.TextBox
    Protected WithEvents txtPassword As
System.Web.UI.WebControls.TextBox
    Protected WithEvents txtPasswordConfirm As
System.Web.UI.WebControls.TextBox
    Protected WithEvents txtFirstName As
System.Web.UI.WebControls.TextBox
    Protected WithEvents txtLastName As
System.Web.UI.WebControls.TextBox
    Protected WithEvents txtStreet As System.Web.UI.WebControls.
TextBox
    Protected WithEvents txtCity As System.Web.UI.WebControls.
TextBox
    Protected WithEvents txtState As System.Web.UI.WebControls.
TextBox
    Protected WithEvents txtPostalCode As
System.Web.UI.WebControls.TextBox
    Protected WithEvents txtCountry As
System.Web.UI.WebControls.TextBox
    Protected WithEvents txtEmail As System.Web.UI.WebControls.
TextBox
#Region " Web Form Designer Generated Code "
    'This call is required by the Web Form Designer.
    <System.Diagnostics.DebuggerStepThrough( )> Private Sub
InitializeComponent( )
    End Sub
    Private Sub Page_Init(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Init
        'CODEGEN: This method call is required by the Web Form
Designer
        'Do not modify it using the code editor.
        InitializeComponent( )
    End Sub
#End Region
```

-continued

```
    Private Sub Page_Load(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Load
        'Put user code to initialize the page here
    End Sub
    Private Sub SignUp_Click(ByVal s As System.Object, ByVal e As
System.EventArgs) Handles btnSignUp.Click
        "Add User to Active Directory
        Dim strDisplayName = txtFirstName.Text & " " & txtLastName.
Text
        Try
            Dim strPath As String =
ConfigurationSettings.AppSettings("LDAPString")
            Dim myDirectoryEntry As New DirectoryEntry(strPath,
ConfigurationSettings.AppSettings("LDAPUser"), "Amsterdam05")
            Dim myNewUser As New DirectoryEntry( )
            myDirectoryEntry.UsePropertyCache = True
            myNewUser = myDirectoryEntry.Children.Add("CN=" &
txtFirstName.Text & " " & txtLastName.Text, "user")
            myNewUser.Properties("sAMAccountName").Value =
txtUsername.Text
            myNewUser.Properties("givenname").Add(txtFirstName.
Text)
            myNewUser.Properties("sn").Add(txtLastName.Text)
            myNewUser.Properties("displayname").
Add(strDisplayName)
'myNewUser.Properties("homeDirectory").Add(ConfigurationSettings.
AppSettings("PhysicalPathtoVMs") & txtUsername.Text)
            myNewUser.CommitChanges( )
            'myNewUser.Password = txtPassword.Text
            myNewUser.Invoke("SetPassword", "Amsterdam0333")
            Dim userflags As Object =
myNewUser.Properties("UserAccountControl")
            myNewUser.Properties("UserAccountControl").Value =
&H220
            myNewUser.Properties("pwdlastset").Value = 0
            'myNewUser.Properties("memberOf")(0).Value =
"CN=VM User,OU=VM_Accounts,DC=TCEDMZ,DC=local"
            myNewUser.CommitChanges( )
System.Diagnostics.Process.Start(ConfigurationSettings.AppSettings
("PhysicalPathtoTools") & "InitialSignup\InitialSignup", txtUsername.
Text)
System.Diagnostics.Process.Start(ConfigurationSettings.AppSettings
("PhysicalPathtoTools") & "RegisterVM\RegisterVM", "dmzvpc03 " &
txtUsername.Text & "_Original-XPPro.vmc " &
ConfigurationSettings.AppSettings("PhysicalPathtoVMs") &
txtUsername.Text & "\")
        Catch ex As Exception
            Response.Write(ex.Message)
        End Try
    End Sub
End Class
```

Once the new user has been created in the active directory **118**, the script **110** continues at block **214** to add the new user to the security group of the active directory **118**, as well as to set the primary group and give the user a full permission set. As shown in FIG. **7**, the script **110** may do this automatically within the "Member of" tab of the user properties window **604**.

Continuing to block **216**, the on-demand cloning module **106** then creates a VM clone **108** from a pre-defined master VM **104** for the new user. In certain embodiments, the user may be able to select from a number of master VMs **104** that have been optimized for different tasks, i.e., word processing, accounting, gaming, etc. The cloning is accomplished, in one implementation, using a batch file that copies a base image of the master VM **104**, creating a new VM clone **108** uniquely renamed for the new subscriber based on the subscriber's PUID **602** (or other unique information, such as e-mail address, login credentials, or other identifying information provided by the user). An example script **110** for carrying out this process is as follows:

```
Imports System.IO
Module Module1
    Sub Main(ByVal CmdArgs( ) As String)
        ' 1. Create New User Directory under VirtualMachines Dir
        ' 2. Move 1st available Master XPPro VM
        ' Syntax: InitialSignup
        '       CmdArgs:
        '           0 – Username
        Dim config As Configuration.ConfigurationSettings
        Dim i As Integer
        Dim objFileWriter As StreamWriter
        For i = 1 To 5
            If File.Exists(config.AppSettings("MoveVM-
XPProMasterFrom") & i & ".vmc") Then
                ' Try
                If Not Directory.Exists(config.AppSettings
("VMPath") & CmdArgs(0)) Then
Directory.CreateDirectory(config.AppSettings("VMPath") &
CmdArgs(0))
                End If
                System.IO.File.Move(config.AppSettings
("MoveVM-XPProMasterFrom") & i & ".vmc", config.
AppSettings("VMPath") & CmdArgs(0) & "\" & CmdArgs(0) &
"_Original-XPPro.vmc")
                System.IO.File.Move(config.AppSettings
("MoveVM-XPProMasterFrom") & i & ".vhd", config.
AppSettings("VMPath") & CmdArgs(0) & "\" & CmdArgs(0) &
"_Original-XPPro.vhd")
                FileReplace(config.AppSettings("VMPath") &
CmdArgs(0) & "\" & CmdArgs(0) & "_Original-XPPro.vmc",
"111222333444555", CmdArgs(0) & "\" & CmdArgs(0) &
"_Original-XPPro")
                FileReplace(config.AppSettings("VMPath") &
CmdArgs(0) & "\" & CmdArgs(0) & "_Original-XPPro.vmc",
"555444333222111", "UTF(-16)")
                Exit Sub
            End If
        Next
    End Sub
    Sub FileReplace(ByVal filePath As String, ByVal oldString As
String, ByVal newString As String)
        Dim sr As StreamReader = New StreamReader(filePath)
        Dim file As String = sr.ReadToEnd( )
        sr.Close( )
        file = file.Replace(oldString, newString)
        Dim sw As StreamWriter = New StreamWriter(filePath)
        sw.Write(file)
        sw.Close( )
    End Sub
End Module
```

While the VM clone **108** is being created, the user may be prompted to wait, as shown in the browser of FIG. **8**, since the process of copying the base image may take several seconds or longer depending on its size.

In certain embodiments, multiple virtual servers **102** are provided for load balancing. Accordingly, in block **218**, the script **110** may pull a list of potential virtual servers **102** to host the new VM clone **108**. The system then attempts to determine which virtual server **102** has the resources (e.g., available memory, CPU resources, etc.) to best handle the new VM clone **108**. In one implementation, this is done in block **220** using an XML (eXtensible Markup Language) file, which pings each of the virtual servers **102** to determine resource availability.

Once a virtual server **102** has been selected, control passes to block **222**, in which the new VM clone **108** is added to the virtual server **102**. This may be accomplished, in one embodiment, using a RegisterVM.exe program, which has the usage "RegisterVM ServerName MachineName MachinePath." Other programs or techniques may also be used for this purpose. A supporting script **110** for this process is as follows:

```
ImportsSystem.Reflection
ImportsSystem.Runtime.InteropServices
Imports Microsoft.VirtualServer.Interop
Public Class InitVS
    <DllImport("ole32.dll", _
        PreserveSig:=False, _
        ExactSpelling:=True, _
        EntryPoint:="CoInitializeSecurity", _
        CallingConvention:=CallingConvention.StdCall, _
        SetlastError:=False)> _
    Private Shared Sub CoInitializeSecurity( _
        ByVal pSD As IntPtr, _
        ByVal cAuthSvc As UInt32, _
        ByVal asAuthSvc As IntPtr, _
        ByVal pReserved1 As IntPtr, _
        ByVal dwAuthnlevel As UInt32, _
        ByVal dwImpLevel As UInt32, _
        ByVal pAuthInfo As IntPtr, _
        ByVal dwCapabilities As UInt32, _
        ByVal pvReserved2 As IntPtr)
    End Sub
    Private Const RPC_C_AUTHN_LEVEL_NONE As Long = 1
    Private Const RPC_C_IMP_LEVEL_IMPERSONATE As Long = 3
    Private Const EOAC_NONE As Long = 0
    Public Sub New ( )
        CoInitializeSecurity(System.IntPtr.Zero, _
            Convert.ToUInt32(0), _
            System.IntPtr.Zero, _
            System.IntPtr.Zero, _
            Convert.ToUInt32(RPC_C_AUTHN_LEVEL_NONE), _
            Convert.ToUInt32(RPC_C_IMP_LEVEL_
IMPERSONATE), _
            System.IntPtr.Zero, _
            Convert.ToUInt32(EOAC_NONE), _
            System.IntPtr.Zero)
    End Sub
    Public Function GetVMVirtualServerClass(ByVal server As
String) _
        As VMVirtualServerClass
        Dim typeVSClass As Type
        Dim typeDCOM As Type
        Dim objDCOM As Object
        typeVSClass = GetType(VMVirtualServerClass)
        typeDCOM = Type.GetTypeFromCLSID(typeVSClass.GUID,
server, True)
        objDCOM = Activator.CreateInstance(typeDCOM)
        GetVMVirtualServerClass = CType( _
            Marshal.CreateWrapperOfType(objDCOM,
typeVSClass), _
            VMVirtualServerClass)
    End Function
    'Get VMVirtualServerClass instance from local server using COM
    Public Function GetVMVirtualServerClass( ) As
VMVirtualServerClass
        GetVMVirtualServerClass = New VMVirtualServerClass
    End Function
End Class
Module RegisterVM
    <MTAThread( )> _
    Sub Main(ByVal CmdArgs( ) As String)            ' Initialize COM
with Impersonate first
        Dim myApp As InitVS
        myApp = New InitVS
        Dim myApp1 As InitVS
        ' Check command line arguments help flag
        If CmdArgs.Length > 0 Then
            If Left$(CmdArgs(0), 1) = "-" Or Left$(CmdArgs(0), 2) =
"/?" Then
                Dim sHelp As String
                sHelp = "USAGE: RegisterVM {servername}
{vmcfile} {vmcpath}
                MsgBox(sHelp, MsgBoxStyle.OKOnly,
"ShowVSVersion Help")
                Exit Sub
            End If
        End If
        ' Connect locally or remotely
        Dim myVS As VMVirtualServer
        Dim myVM As VMVirtualMachine
        Dim myVSErrMsg As String
```

-continued

```
        Try
            If CmdArgs.Length > 0 Then
                myVSErrMsg = " at " & CmdArgs(0)
                myVS = myApp.GetVMVirtualServerClass
(CmdArgs(0))
                myVM = myApp1.GetVMVirtualServerClass
(CmdArgs(0))
            Else
                myVSErrMsg = " on local machine"
                myVS = myApp.GetVMVirtualServerClass( )
                myVM = myApp1.GetVMVirtualServerClass( )
            End If
        Catch ex As Exception
            MsgBox("Cannot connect to Virtual Server" &
myVSErrMsg, MsgBoxStyle.OKOnly, "ShowVSVersion")
            Exit Sub
        End Try
        myVS.CreateVirtualMachine(CmdArgs(1), CmdArgs(2))
        myVM.AddHardDiskConnection(CmdArgs(2) & CmdArgs(1),
VMDriveBusType.vmDriveBusType_IDE, 0, 1)
    End Sub
End Module
```

Once the new VM clone **108** has been added to the virtual server **102**, it will appear in a listing of VMs on the virtual server **102**, as shown in FIG. **9**. In the present example, the new VM clone **108** is at the top of the list and shows a running time of 6 seconds. Note that each of the VM clones **108** have a "virtual machine name" based on a different PUID **602** for a respective subscriber.

Continuing at block **224**, the script **110** starts and tests the new VM clone **108**. FIG. **10** illustrates a POST (Power On Self Test) screen generated by the VM clone during the booting process, which is displayed in the subscriber's browser. Thereafter, as shown in FIG. **11**, the Windows XP™ (or another OS) startup screen is displayed as the VM clone **108** continues by loading the installed OS.

At block **226**, the script **110** may initiate an auto-login procedure, as shown in FIG. **12**, causing the VM clone **108** to automatically log into the "Administrator" account, or another account with suitable privileges to permit system-level changes to various OS settings, as described below. A modification to the system registry for accomplishing the auto-login procedure is as follows:

```
Windows Registry Editor Version 5.00
[HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\
    Windows NT\CurrentVersion\Winlogon]
"DefaultUserName"="administrator"
"DefaultUserPassword"=""
"AutoAdminLogon"="1"
```

For example, at block **228**, the system may run a WMI script against the new VM clone **108**, changing the computer name based, in one embodiment, on information from the subscriber profile form **502**. An example of a suitable WMI script is as follows:

```
strComputer="."
Set objWMIService=
GetObject("winmgmts:
    {impersonationLevel=impersonate}!\\" & strComputer
    & "\root\cimv2")
Set colComputers=objWMIService.ExecQuery ("Select *
    from Win32_ComputerSystem")
For Each objComputer in colComputers
    err=ObjComputer.Rename(WScript.arguments.item
        (0))
    Wscript.Echo err
Next
```

Similarly, at block **230**, the system may run a WMI script adding the new VM clone **108** to a particular domain or workgroup, also based on information from the subscriber profile form **502**. For example, the user may specify that he or she wants to be a part of a particular workgroup or domain of a "virtual office" provided by the present system **100**.

At block **232**, the script **110** will reboot the new VM clone **108** to make all of the necessary changes to the system registry (or other similar data structure in a non-Windows 2000/XP environment). The process of shutting down Windows and rebooting is illustrated in FIG. **13**, which may be performed automatically without the need for intervention by the subscriber. One possible script for carrying out this procedure may include the command, "shutdown /r /t 1 /d p:2:3/c 'Shutting Down VM.'"

Once the VM clone **108** has been rebooted, the subscriber is taken, at block **234** to an ActiveX webpage displaying the new VM clone **108**, as shown in FIG. **14**. The subscriber can then, at block **236**, access VM from any PC connected to the Internet using their Microsoft Passport.

Because the VM clones **108** are centrally hosted on one or more virtual servers **102**, they may be easily updated or repaired by service personnel without having to make an in-home visit. For example, updates to virus scanners or the operating system, itself, may be automatically made by administrators of the virtual servers **102**. Moreover, if the user desires a new software application, the user may simply purchase it online, after which the application may be automatically installed on the user's VM clone **108**. Automatic backups of the VM clone **108** may be made daily or even more frequently, permitting service personnel to easily troubleshoot serious problems with a minimum of downtime.

Furthermore, the user may easily "upgrade" the VM clone **108** with more power "hardware." Since the VM clone's "CPU" is merely a share of the processing resources of a physical computer hosting the virtual server **102**, that share may be increased or decreased based on the user's needs. In fact, processing, graphics, sound, networking, and other resources can be allocated on an application-by-application basis. For instance, the VM clone **108** may not normally provide computer gaming capability. However, should the user desire to run one of the latest games, his or her "machine" may be temporarily "upgraded" with the requisite virtual hardware, the cost of which would be billed to the user, since the upgraded machine would be using a greater share of the physical host system.

As noted above, the foregoing embodiment is specific to a subscriber creating a new VM clone **108** to be accessed over the Internet. In an alternative embodiment, a corporation may provide its employees with VM clones **108** hosted on a corporate server. Accordingly, rather than providing each employee with a separate, full-featured computer, the corporation may provide each employee with a basic terminal with a Web browser, as well as a hosted VM clone **108** with all of the necessary software and settings for the employee's job description.

The process flow described in FIG. **2** would only be changed in minor ways in a corporate environment. For example, FIG. **15** partially illustrates the corporate process, which begins at block **1500** with the employee accessing any corporate terminal. Moving to block **1502**, the employee clicks on a shortcut, which opens an internal MyvPC.local sign-in page **1502**, as illustrated in FIG. **16**. In this case, the employee would not log in using .NET Passport (as in FIG. **4**), but rather, would log in with the employee's corporate login credentials or a pre-assigned guest/demo/training account.

For greater security, the employee may log in with an external e-mail address. In response, the system **100** may send an e-mail message to the specified address containing a spe-

cial link to the Web server **116** which facilitates online creation of, or access to, a VM clone **108**. Accordingly, the user cannot use a VM clone **108** unless he or she provides a valid external e-mail address during the login procedure.

At block **1504**, the user may be authenticated, for example, using standard LDAP authentication. Once the user is authenticated, a screen display similar to the one in FIG. **17** may be shown, which indicates that the user "cp" has been authenticated using LDAP authentication.

Continuing to block **1506**, the system **100** may search the MyvPC.local active directory **118** for an existing user based on the employee's login credentials, i.e., username and password. If the user exists in the active directory **118**, control passes to block **1508**, in which the employee is taken to an ActiveX page, which displays the employee's VM in its last known state. This process is illustrated in FIG. **18**.

If, however, the user does not exist in the active directory **118** (e.g., a new employee), control passes to block **1510** in which the employee completes an employee profile form. The employee profile form may be similar to the new subscriber profile form **502** of FIG. **5**. Alternatively, the employee profile form may have been completed previously, in which case information from the form may be accessed from a stored location.

Continuing to block **1512**, the script **110** will create a new user object in the active directory **118** based on the employee's login credentials. Thereafter, in block **1514**, the script **110** will add the new user object to a security group of the active directory **118**, as well as to set a primary group for the new user object.

In block **1516**, the script **110** will create a clone of a pre-defined (or user-selected) master VM **104**. In one embodiment, this is accomplished using a batch file that copies a base image of the master VM **104**, creating a new VM clone **108** uniquely renamed for the new employee based, for example, on the employee's login credentials.

The remainder of the process flow may occur essentially as outlined in the remainder of FIG. **2**. For example, the system **100** may selectively assign the VM clone **108** to the virtual server **102** best able to accommodate it. Additionally, the system **100** may boot the VM clone **108** within the selected virtual server **102**, automatically logging in the VM clone **108** into an "administrator" account or the like in order to enable changing the computer name and/or adding the VM clone **108** to a particular corporate domain or workgroup.

The above-described process of hosting VM clones **108** results in many benefits to a corporation, not the least of which is eliminating the cost of providing a full-featured computer to each employee. In addition, using the principles discussed herein, the corporation may install updates, enforce security policies, and troubleshoot systems much more easily than the conventional model, in which the corporation purchases individual computers for employees.

While specific embodiments and applications of the present invention have been illustrated and described, it is to be understood that the invention is not limited to the precise configuration and components disclosed herein. Various modifications, changes, and variations apparent to those of skill in the art may be made in the arrangement, operation, and details of the methods and systems of the present invention disclosed herein without departing from the spirit and scope of the present invention.

Embodiments of the invention may include various steps, which may be embodied in machine-executable instructions to be executed by a general-purpose or special-purpose computer (or other electronic device). Alternatively, the steps may be performed by hardware components that contain specific logic for performing the steps, or by any combination of hardware, software, and/or firmware.

Embodiments of the present invention may also be provided as a computer program product including a machine-readable medium having stored thereon instructions that may be used to program a computer (or other electronic device) to perform processes described herein. The machine-readable medium may include, but is not limited to, floppy diskettes, optical disks, CD-ROMs, DVD-ROMs, ROMs, RAMs, EPROMs, EEPROMs, magnetic or optical cards, propagation media or other type of media/machine-readable medium suitable for storing electronic instructions. For example, instructions for performing described processes may be transferred from a remote computer (e.g., a server) to a requesting computer (e.g., a client) by way of data signals embodied in a carrier wave or other propagation medium via a communication link (e.g., network connection).

What is claimed is:

1. A system, comprising:

a computing device comprising a processor and a memory,

a virtual server resident on the memory and operating on the processor to host a number of virtual machines (VMs), the virtual server including at least one master VM having a base image stored on a non-transitory non-volatile computer-readable storage medium, the base image comprising an operating system;

a Web server resident on the memory and operating on the processor to authenticate a user based upon a user credential in response to a request for online access to a new VM on the virtual server;

a cloning module resident on the memory and operating on the processor, in communication with the Web server and the virtual server, to automatically clone a master VM to create a VM clone for the user on the virtual server responsive to the request, wherein the VM clone comprises a copy of the base image on the non-transitory non-volatile computer-readable storage medium, and wherein the cloning module is to create the VM clone by copying the base image and renaming the copied image according to unique information pertaining to the user, wherein the unique information comprises a passport unique identifier; and

wherein the Web server comprises a common interface configured to provide access to the cloning module for creating the VM clone for the user and to provide access to the deployed VM clone of the user based upon the same user credential.

2. The system of claim **1**, wherein the unique information comprises identification information provided by the user.

3. The system of claim **1**, wherein the unique information comprises one or more login credentials of the user.

4. The system of claim **1**, wherein the Web server is to authenticate the user with a .NET Passport authentication system that returns the passport unique identifier in response to the user being successfully authenticated.

5. The system of claim **1**, wherein the cloning module is further to create a new user object in an active directory according to the unique information pertaining to the user.

6. The system of claim **5**, wherein the unique information comprises identification information provided by the user.

7. The system of claim **5**, wherein the unique information comprises one or more login credentials of the user.

8. The system of claim **5**, wherein the cloning module is further to add the new user object to a security group of the active directory as well as to set a primary group for the new user object.

9. The system of claim 1, wherein the cloning module is further to check resources of a plurality of virtual servers to select a virtual server with adequate resources to host the VM clone and assign the VM clone to the selected virtual server.

10. The system of claim 9, wherein the cloning module is further to boot the VM clone using an auto-login sequence into an administrator account.

11. The system of claim 10, wherein the cloning module is further to execute a script while the VM clone is logged into the administrator account to change a computer name associated with the VM clone.

12. The system of claim 11, wherein the cloning module is further to execute a script while the VM clone is logged into the administrator account to add the VM clone to a domain.

13. The system of claim 11, wherein the cloning module is further to execute a script while the VM clone is logged into the administrator account to add the VM clone to a workgroup.

14. The system of claim 1, wherein the cloning module includes a Lightweight Directory Access Protocol (LDAP) script, and wherein the cloning module uses the LDAP script to clone the master VM.

15. The system of claim 1, wherein the cloning module, in response to a user being authenticated, determines whether the user has an existing VM clone and, in response to the user having an existing VM clone, provides the user with online access to the VM clone.

16. The system of claim 15, wherein the cloning module is to determine whether the user has an existing VM clone by checking for a VM clone uniquely named according to the passport unique identifier of the user.

17. The system of claim 1, wherein the cloning module is further to prompt the user to select a master VM for cloning from a plurality of master VMs, each master VM being optimized for a different set of tasks.

18. A method, comprising:

providing a virtual server to host a number of virtual machines (VMs), the virtual server comprising at least one master VM, each master VM having a respective base image stored on a non-transitory non-volatile computer-readable storage medium, the base image comprising an operating system, wherein the virtual server comprises a base image for the master VM, and wherein creating the VM clone comprises:

renaming the copy of the base image according to unique information pertaining to the user, wherein the unique information comprises a passport unique identifier;

authenticating a user based upon a user credential in response to a request for online access to a new VM on the virtual server;

automatically cloning a master VM to create a VM clone for the user on the virtual server responsive to the request, wherein the VM clone comprises a copy of the base image of the master VM on the non-transitory non-volatile computer-readable storage medium;

upgrading hardware resources originally allocated to the VM clone in response to a request from the user, wherein upgrading comprises providing access to one or more of, graphics hardware and networking hardware not originally accessible to the VM clone; and

reverting to the hardware resources originally allocated to the VM clone after a pre-determined time.

19. The method of claim 18, wherein the unique information comprises identification information provided by the user.

20. The method of claim 18, wherein the unique information comprises one or more login credentials of the user.

21. The method of claim 18, wherein authenticating comprises authenticating the user with a .NET Passport authentication system that returns the passport unique identifier in response to the user being successfully authenticated.

22. The method of claim 18, further comprising creating a new user object in an active directory according to the unique information pertaining to the user.

23. The method of claim 22, wherein the unique information comprises identification information provided by the user.

24. The method of claim 22, wherein the unique information comprises one or more login credentials of the user.

25. The method of claim 22, further comprising adding the new user object to a security group of the active directory as well as to set a primary group for the new user object.

26. The method of claim 18, further comprising:

checking resources of a plurality of virtual servers to select a virtual server with adequate resources to host the VM clone; and assigning the VM clone to the selected virtual server.

27. The method of claim 26, further comprising booting the VM clone using an auto-login sequence into an administrator account.

28. The method of claim 27, further comprising executing a script while the VM clone is logged into the administrator account to change a computer name associated with the VM clone.

29. The method of claim 28, further comprising executing a script while the VM clone is logged into the administrator account to add the VM clone to a domain.

30. The method of claim 28, further comprising executing a script while the VM clone is logged into the administrator account to add the VM clone to a workgroup.

31. The method of claim 18, further comprising using a Lightweight Directory Access Protocol script to clone the master VM.

32. The method of claim 18, further comprising:

determining, in response to a user being authenticated, whether the user has an existing VM clone; and in response to the user having an existing VM clone, providing the user with online access to the VM clone.

33. The method of claim 32, wherein determining whether the user has an existing VM clone comprises checking for a VM clone uniquely named according to ft the passport unique identifier of the user.

34. The method of claim 18, further comprising prompting the user to select a master VM for cloning from a plurality of master VMs, each master VM being optimized for a different set of tasks.

35. An article of manufacture, comprising a non-transitory computer-readable storage medium comprising computer-readable code including:

computer-readable code to authenticate a user based on a user credential in response to a request for online access to a new virtual machine on a virtual server, the virtual server including at least one master VM, the master VM having a base image stored on a non-transitory non-volatile computer-readable storage medium, the base image comprising an operating system;

computer-readable code to automatically clone a master VM to create a VM clone for the user on the virtual server responsive to the request, wherein the VM clone comprises a copy of the base image on the non-transitory non-volatile computer-readable storage medium, wherein the computer-readable code to automatically clone the master VM is to create the VM clone by renaming the copy of the base image according to unique

information pertaining to the user, wherein the unique information comprises a passport unique identifier; and

computer-readable code to provide a common interface configured to provide for cloning the master VM to create the VM clone for the user and accessing to the cloned VM of the user based upon the same user credential.

36. The article of manufacture of claim **35**, wherein the unique information comprises identification information provided by the user.

37. The article of manufacture of claim **35**, wherein the unique information comprises one or more login credentials of the user.

38. The article of manufacture of claim **35**, wherein the computer-readable code to authenticate a user employs a .NET Passport authentication system that returns the passport unique identifier in response to the user being successfully authenticated.

39. The article of manufacture of claim **35**, wherein the computer-readable code to automatically clone the master VM is further to create a new user object in an active directory according to the unique information pertaining to the user.

40. The article of manufacture of claim **39**, wherein the unique information comprises identification information provided by the user.

41. The article of manufacture of claim **39**, wherein the unique information comprises one or more login credentials of the user.

42. The article of manufacture of claim **39**, wherein the computer-readable code to automatically clone the master VM is further to add the new user object to a security group of the active directory as well as to set a primary group for the new user object.

43. The article of manufacture of claim **35**, wherein the computer-readable code to automatically clone the master VM is further to check resources of a plurality of virtual servers to select a virtual server with adequate resources to host the VM clone and assign the VM clone to the selected virtual server.

44. The article of manufacture of claim **43**, wherein the computer-readable code to automatically clone the master VM is further to boot the VM clone using an auto-login sequence into an administrator account.

45. The article of manufacture of claim **44**, wherein the computer-readable code to automatically clone the master VM is further to execute a script while the VM clone is logged into the administrator account to change a computer name associated with the VM clone.

46. The article of manufacture of claim **45**, wherein the computer-readable code to automatically clone the master VM is further to execute a script while the VM clone is logged into the administrator account to add the VM clone to a domain.

47. The article of manufacture of claim **45**, wherein the computer-readable code to automatically clone the master VM is further to execute a script while the VM clone is logged into the administrator account to add the VM clone to a workgroup.

48. The article of manufacture of claim **35**, wherein the computer-readable code to automatically clone the master VM uses a Lightweight Directory Access Protocol script for cloning the master VM.

49. The article of manufacture of claim **35**, wherein the computer-readable code to automatically clone the master VM, in response to a user being authenticated, determines whether the user has an existing VM clone and, in response to the user having an existing VM clone, provides the user with online access to the VM clone.

50. The article of manufacture of claim **49**, wherein the computer-readable code to automatically clone the master VM is to determine whether the user has an existing VM clone by checking for a VM clone uniquely named according to the passport unique identifier of the user.

51. The article of manufacture of claim **35**, wherein the computer-readable code to automatically clone the master VM is further to prompt the user to select a master VM for cloning from a plurality of master VMs, each master VM being optimized for a different set of tasks.

52. An apparatus comprising a computing device comprising a processor for providing on-demand access to virtual machines (VMs), comprising:

means for authenticating a user based upon a user credential in response to a request for online access to a new VM on a virtual server, the virtual server comprising a plurality of master VMs representing personal computers optimized for different sets of tasks, wherein each master VM comprises a respective base image stored on a non-transitory non-volatile computer-readable storage medium, the base image comprising an operating system;

means for automatically cloning a selected one of the master VMs to create a VM clone for the user on the virtual server responsive to the request, wherein the selection is based on the set of tasks for which the selected master VM is optimized, and wherein the means for automatically cloning comprises means for creating a copy of the base image of the selected master VM on the non-transitory non-volatile computer-readable storage medium, wherein creating the VM clone comprises:

renaming the copy of the base image according to unique information pertaining to the user, wherein the unique information comprises a passport unique identifier; and

means for upgrading hardware resources allocated to the VM clone in response to a user request and reverting to hardware resources originally allocated to the VM clone after a pre-determined time, wherein upgrading the hardware resources comprises providing access to one or more of graphics hardware and networking hardware not originally accessible to the VM clone.

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